



Magnetospheric MultiScale Mission (MMS)

Magnetospheric MultiScale Mission

SpaceWire Implementation

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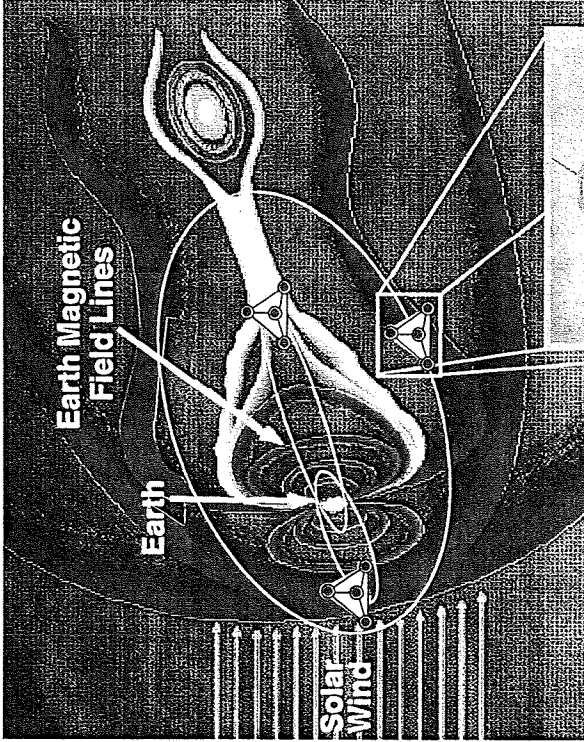
N A S A G O D D A R D S P A C E F L I G H T C E N T E R



MMS Mission Overview



Magnetospheric Multiscale Mission (MMS)



Mission Team

NASA SMD
Southwest Research Inst
Science Leadership
Instrument Suite
Science Operations Center
NASA GSFC
Project Management
Mission System Engineering
Spacecraft
Mission Operations Center
NASA KSC
Launch services

Science Objectives

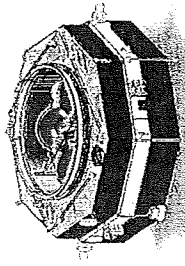
Discover the fundamental plasma physics process of reconnection in the Earth's magnetosphere
Temporal scales of milliseconds to seconds
Spatial scales of 10s to 100s of km

Mission Description

4 identical satellites
Formation flying in a tetrahedron
2 year operational mission

Orbits

Elliptical Earth orbits in 2 phases
Phase 1 day side of magnetic field $1.2 R_E$ by $12 R_E$
Phase 2 night side of magnetic field $1.2 R_E$ by $25 R_E$
Significant formation flying and orbit adjust requirements



Instruments

Identical *in situ* instruments on each satellite measure
Electric and magnetic fields
Fast plasma
Energetic particles
Hot plasma composition

Spacecraft

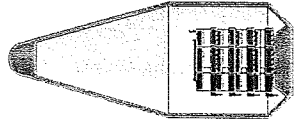
Spin stabilized at 3 RPM
Intersatellite ranging system

Launch vehicle

4 satellites launched together in one Evolved
Expendable Launch Vehicle (EELV)

Mission Status

Currently in Phase A
Launch in 2013



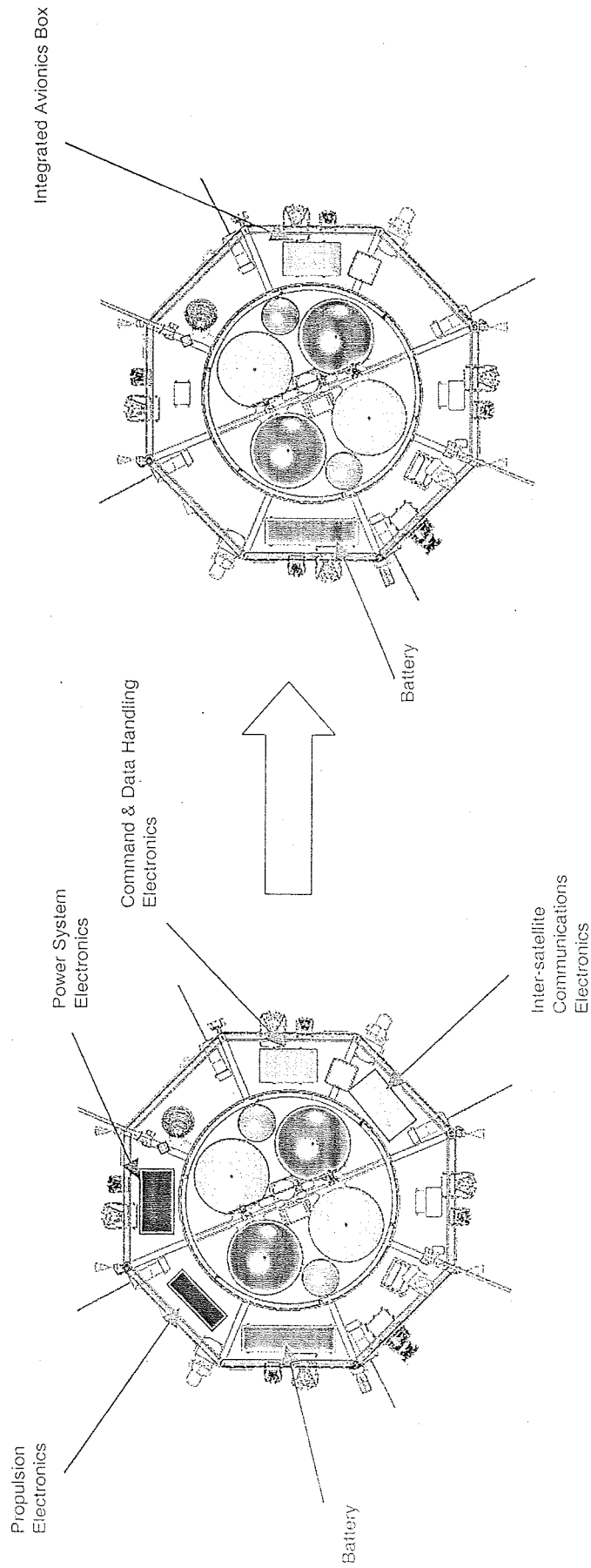


MMS Spacecraft Avionics



Magnetospheric Multiscale Mission (MMS)

- Traditional spacecraft avionics systems use separate electronics boxes for each function.
- MMS has baselined an integrated avionics architecture, in order to save power, mass and reduce integration and test cost.

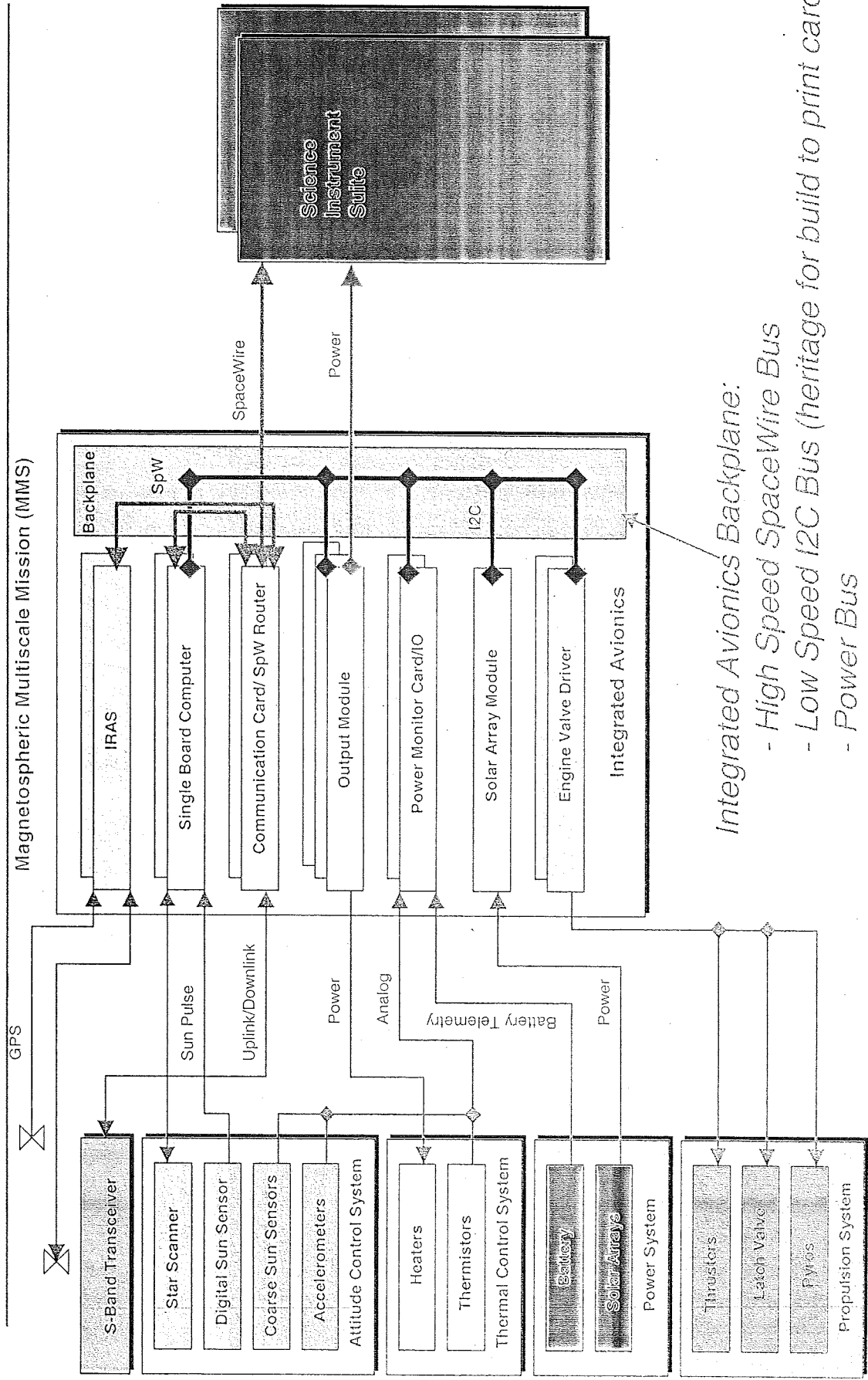


Traditional Avionics Approach

MMS Integrated Avionics Approach



Spacecraft Avionics Block Diagram





Internal Backplane Communications



Magnetospheric Multiscale Mission (MMS)

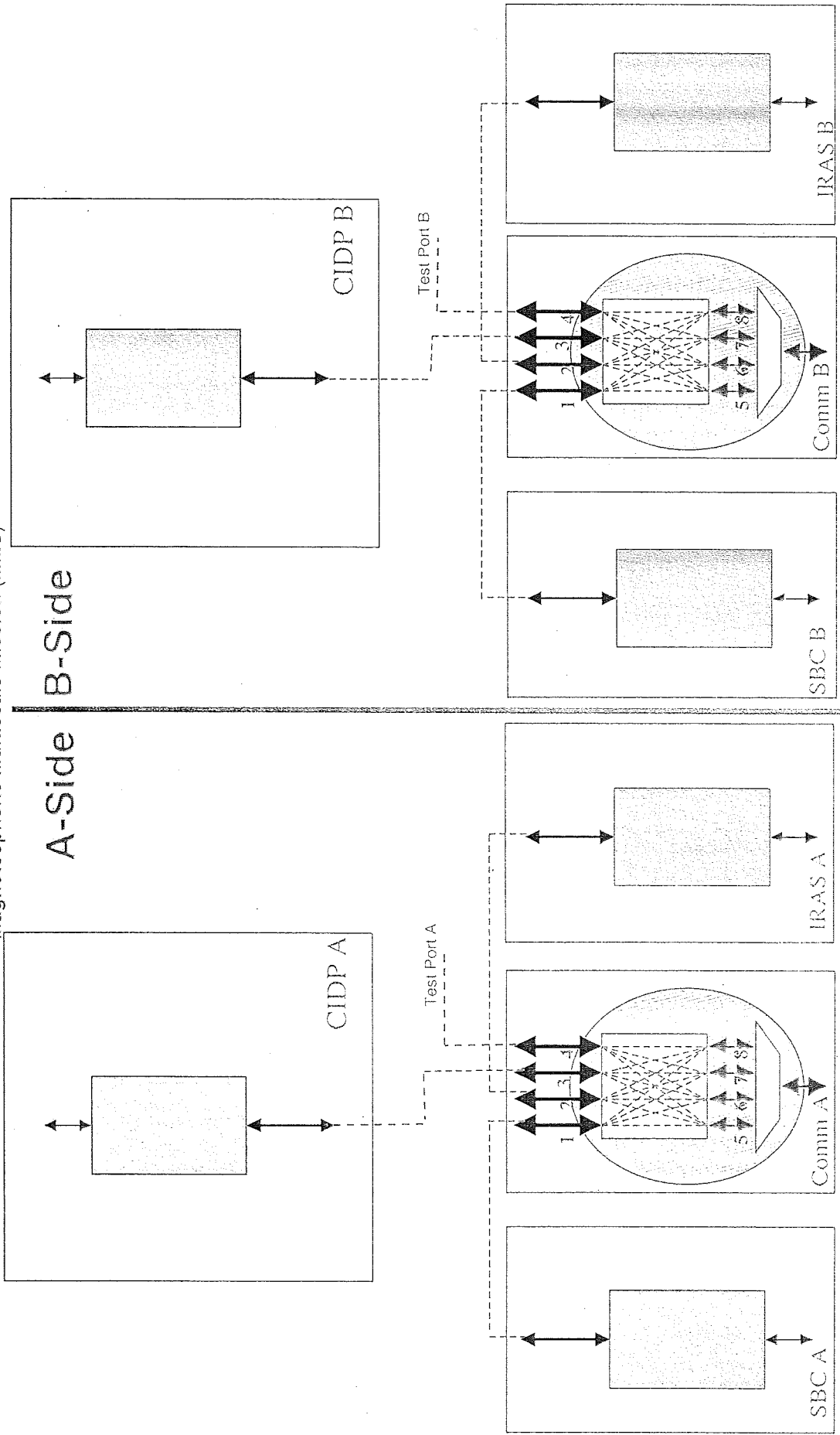
- **Low speed communications between integrated avionics subsystems will occur over an internal I2C bus**
 - This bus is used because of heritage build to print boards
 - power system electronics boards
 - This bus will be eliminated in future integrated avionics systems
- **Higher speed communications between integrated avionics subsystems will occur over an internal SpaceWire backplane.**
 - Remote Memory Access Protocol will support I/O and memory transactions.
 - Distributed Interrupt Time-Code mechanism will support sideband signaling.
 - Require multiple side band signaling
 - Need to investigate handshaking mechanism for system operation to see if it will meet requirements
 - Time Code Protocol will support internal time distribution.
- **SpaceWire will replace the traditional cPCI bus for MMS**



MMS Avionics SpaceWire Network



Magnetospheric Multiscale Mission (MMS)





Summary of MMS SpaceWire Implementation



Magnetospheric Multiscale Mission (MMS)

- NASA is interested in the SpaceWire Backplane Standardization for MMS and future flight missions.
- MMS should be the first NASA mission to fly several new SpaceWire protocols including:
 - Remote Memory Access Protocol
 - Distributed Interrupt Protocol
 - Standardized Backplane
- We look forward to working with the SpaceWire Working Group to help make the new SpaceWire protocols successful for MMS and future missions.



MMS Avionics Development Schedule



Magnetospheric Multiscale Mission (MMS)

- ETU fabrication is scheduled to begin in Fall 2008.
- Flight fabrication is scheduled to begin in Spring 2009.
- The SpaceWire Backplane Connector Standard and connector flight qualification program would need to meet the MMS ETU and Flight fabrication milestones.
- Need SpaceWire Backplane Standard definition and flight qualified connector by Spring 2008
 - Would like to be part of the SpW backplane connector working group
- Distributed Interrupt TC requires a clear message (poll message) to enable another TC
 - Some systems simply want to have more side band signals and from multiple sources



Backup SpaceWire Advantages for MMS

Magnetospheric Multiscale Mission (MMS)

- SpaceWire backplane should be simpler than cPCI.
- Reduces the number of interfaces between the Instrument Suite and the Spacecraft.
 - 1553, Custom LVDS, and RS-422 UART Interfaces were replaced by a single SpaceWire Interface.
 - Reduces the number of harnesses between the Instrument Suite and Spacecraft.
- Reduces the technical risks associated with custom interfaces.
 - Designing to an industry standard reduces the risk of ICD custom interface misinterpretation.
- Reduces interface complexity between the Instrument Suite and the Spacecraft.
 - A single SpaceWire interface is simpler than a mixed bag of two standards (1553 and RS-422) and one non-standard (custom LVDS) interface.
- Provides a more flexible architecture.
 - Enables easier cross-strapping between the A and B sides.
 - Allows variable data rates.
 - Packet sizes are not restricted (1553 restricts packets to < 64 bytes).
 - Enables communication from the Instrument Suite to the IRAS, Communications Card, or the Single Board Computer over a single interface link.
- Improvements in Observatory Integration and Test.
 - I&T is simplified with a single SpaceWire interface between the IS and SC.
 - Enables remote I&T between GSFC and SwRI.
- Reduces GSE development engineering.
 - SpaceWire GSE exists for JWST and LRO. Should be able to re-use this GSE for MMS with minor changes.